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[LITERAL TRANSLATION OF PCT INTERNATIONAL APPLICATION PCT/DE99/03438 FILED ON OCTOBER 28, 1999]

TITLE OF THE INVENTION

INSULATING ARRANGEMENT FOR THE INNER INSULATION OF AN AIRCRAFT

FIELD OF THE INVENTION

The invention relates to an insulating arrangement for the inner insulation of an air vehicle [according to the preamble of the claim 1].

BACKGROUND INFORMATION

It is known that the primary insulation located on the structure side for insulation systems presently used in aircraft construction essentially consists of an insulation [base] core material and a film covering or encasing this insulation (core material). The core material of the insulation system is protected against water entry with the conventionally utilized films. Moreover, the film covering or casing serves to secure [for the securing of] the partially bulky or flossy insulation material. Generally, this film casing or covering is dimensioned [in such a manner] so that it contributes the [has] lowest possible weight to the overall insulation system [portions]. In this context, [it can be determined, that] due to the relatively thin film, [upon the occurrence of] water vapor diffuses [diffusion] through the film wall, [the water vapor] and penetrates into the film-covered insulation packet. Thereby, the water vapor partially condenses [out] in the insulation packet. Moreover, diffused liquid particles or water droplets [(water) always] repeatedly enter into the insulation packet through unsealed or leaky areas in the insulation packet or in the film covering. Due to the [The] condensation in the insulation packet, [leads to the result that a collecting of] the liquid particles or water droplets collect [(of the water) occurs] in the insulation

material, ~~which~~ and this accumulated water may only be removed by additional drying efforts. This ~~fact~~ also has a very unpleasant effect, ~~because~~ namely that the insulation system gains in weight due to the water accumulation~~(s)~~ and thereby leads to an unnecessary increase of the weight of ~~an~~ the aircraft.

SUMMARY OF THE INVENTION

~~As a result~~ In view of the above, the invention is based on the object, to embody an insulation arrangement of the above mentioned type so that nearly no humid or moist air or other moist gas or water Vapor or droplets ~~(vapor) particles~~ will penetrate into ~~a~~ the film-covered insulation packet, and so that any moisture that does accumulate in the insulation packet ~~by means of suitable measures (and air guidances), while oppositely (in connection with an accumulation that has occurred in that manner), the accumulated moisture~~ shall quickly escape without hindrance from the insulation packet.

<INSERT Ⓐ from next page 2A>

~~This object is achieved by the measures defined in the claim 1. Advantageous embodiments of these measures are defined in the further claims.~~

BRIEF DESCRIPTION OF THE DRAWINGS

<INSERT Ⓑ from next page 2A>

~~The invention is described in greater detail in an example embodiment with reference to the accompanying drawings. It is shown by:~~

~~Fig. 3: the insulation arrangement according to Fig. 2 with the film covering consisting of a film.~~

DETAILED DESCRIPTION OF PREFERRED EXAMPLE EMBODIMENTS OF THE INVENTION

~~In the~~ Fig. 1 illustrates a conventional~~ly utilized~~ insulation arrangement for an aircraft, ~~is illustrated, which one installs~~ installed in a known manner within an interspace (hollow space) which is bounded by

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[INSERT (A) FOR PAGE 2, LINE 14]

The above objects have been achieved according to the invention in an insulation packet comprising an insulation material completely surrounded and encased by a film that is selectively permeable to the diffusion of gases such as water vapor therethrough. Particularly, the film has a different diffusion resistance in an inward diffusion direction through the film in comparison to an outward diffusion direction through the film. Preferably, the film exhibits a higher diffusion resistance coefficient with respect to gas diffusion in the inward diffusion direction from outside of the packet to inside of the packet, and a lower diffusion resistance coefficient for gas diffusion in the outward diffusion direction from inside of the packet to outside of the packet. The gas of interest is especially water vapor.

The above objects have further been achieved according to the invention in a preferred embodiment, in which the above mentioned insulation packet is provided as an improved insulation packet of an insulation arrangement of an air vehicle, including an outer skin, an inner trim component that is spaced apart from the outer skin with an interspace therebetween, and the insulation packet arranged in the interspace. Preferably, the film of the insulation packet includes a first film section on an outer side of the packet facing toward the outer skin and a second film section on an inner side of the packet facing toward the inner trim component. The first film section provides a relatively lower diffusion resistance in a direction out of the packet toward the outer skin, while the second film section provides a relatively higher diffusion resistance in a direction from the inner trim component into the packet.

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As a result of the above characteristic features of the invention, the film hinders the penetration of water vapor into the insulation packet, and preferentially allows water vapor inside the packet to diffuse out of the packet through the film.

[INSERT (B) FOR PAGE 2, LINE 17]

In order that the invention may be clearly understood, it will now be described in greater detail in connection with example embodiments, with reference to the accompanying drawings, wherein:

Fig. 1 is a schematic sectional view of a conventional insulation arrangement in a wall of an aircraft, including an insulation packet arranged in an interspace between an inner trim component and an outer skin;

Fig. 2 is a schematic sectional view similar to Fig. 1, but showing the inventive insulation arrangement with an improved insulation packet including a selectively gas permeable film covering; and

Fig. 3 is a schematic sectional diagram of a film packet according to the invention, graphically representing the directionally dependent gas diffusion resistance of the film that covers the packet.

the inner region A and the structure region B of the aircraft. In practice, the interspace 7 is formed ~~by~~ between the metal outer skin 6 (allocated to the structure region B) and an inner trim component 12, for example a plate-like cabin trim panel arranged at a spacing from the outer skin 6. In this context, the inner trim component 12 largely follows the curvature of the outer skin 6, whereby a straight linear contour ~~vertical position~~ of both of these components ~~means~~ is selected for simplicity ~~in the~~ Figs. 1 and 2. The inner trim component 12 is provided with machined-in slits or ~~(other)~~ holes or penetrations at certain locations, through which ~~(generally) relatively warm (cabin)~~ cabin air 9, which is generally relatively warm and has ~~comprises~~ a relatively high moisture or humidity content, penetrates into the interspace 7. The actual insulation arrangement comprises ~~is made up of~~ an insulation packet 1 and a conventional film covering i.e. ~~(~~film 4~~)~~ of synthetic plastic, which encases or covers the above mentioned bulky or flossy insulation material, or insulation material consisting of a foam, ~~(~~of the insulation packet 1~~)~~, for the purpose of securing the same. An air gap s is formed between the insulation packet 1 and the outer skin 6.

~~In the~~ The conventional~~ly utilized~~ insulation arrangement of known insulation systems, uses films 4 ~~are used, which~~ that largely prevent ~~a~~ the entry of liquid water ~~entry~~ (entry of water, moist or humid air or other moisture), yet are not ~~(water)~~ vapor tight due to their low density or tightness or due to the low diffusion resistance coefficient of the film covering. This is ~~circumstance has~~ especially disadvantageous ~~hindering effects~~ on the film region or area directed toward the warmer cabin side of the insulation arrangement ~~an aircraft~~. ~~Since the~~ The forward penetration of the relatively warm cabin air 9 ~~(cabin air)~~ through the

slits and cut-out notches of the inner trim component 12 (cabin trim paneling) continues to the surface of the film 4, moreover, . Thus the air 9 loaded with a high air moisture or humidity content can get into the insulation packet 1 through the film wall by an expected water vapor diffusion process.

Since during the cruise flight phase of the aircraft, (predominantly in cruise flight) a strong cooling of the outer skin 6 to approximately -50°C (minus fifty degrees Celsius) will occur, . Thus, it cannot be avoided, that the moisture contained in the water vapor condenses (due to falling below the dew point) condenses out. The result will be a collecting or accumulating of moisture or ice in the insulation packet 1. During the landing and ground operation phase of the aircraft, the temperature of the outer skin 6 will increase. During this phase, the ice in the insulation packet 1 will correspondingly melt to become water. The water in the insulation packet 1, which is located in the insulation packet 1, will, however, only be able to leave or escape from the insulation packet 1 through larger (microporous) openings (not shown) in the film wall. It is, however, disadvantageous, that therefore the possibility also exists, that water will once again enter into the insulation packet 1 through these film openings.

The release of water through the film wall in the form of water vapor is, however, only possible during a limited time, since (generally for reasons) the ground time of a commercial transport aircraft will generally be maintained kept relatively short, and the conventionally utilized film 4 (film covering) is not laid out for a more rapid release of ~~water~~ vapor out of the insulation packet 1. This The above mentioned diffusion process (as has been mentioned initially above) will lead to an undesired accumulation of condensate water in the known insulation packets 1 that are encased or covered with a conventional film 4. ~~Additionally~~

~~effective disadvantages of the conventional insulation arrangement were also given initially above.~~

In the following, the example embodiments of the invention will be ~~according to the Figures 2 and 3 will be~~ described in greater detail with reference to Figs. 2 and 3. For the sake of a better understanding, the insulation arrangement according to Fig. 3 will first be considered in greater detail. An insulation structure or arrangement is contemplated, which is made up of an insulation packet 1 and a film 5, which completely encases or covers the insulation packet 1, according to the example of Fig. 1. The installed arrangement of this insulation structure or arrangement, which will similarly correspond to the arrangement according to Fig. 1, has been omitted from this schematic figurative illustration. According to the two Figs. Figures 2 and 3, generally a film arrangement is contemplated, which is made up of a (only) one single film 5 (encasing the insulation packet 1) or of two ~~films~~ or film sections 2, 3 (encasing the insulation packet 1) which two film sections are integrated into a single film 5 (intended according to the example of Fig. 3). Both film arrangements are generally realized with a gas-permeable film material that is permeable by gases, with which having a different diffusion resistance characteristic or behavior is achieved dependent upon the diffusion direction of the total structure from the moist humid or damp inner space 7 to the cold outer skin 6.

With reference to the Fig. 3, the differential diffusion resistance characteristic of the film 5 is achieved realized with a film material which provides a high diffusion resistance coefficient with respect to inward diffusion through the film from the film outer wall surface to the film inner wall surface, and provides a low diffusion resistance coefficient in the opposite

diffusion direction (namely[,] from the film inner wall surface to the film outer wall surface). This above described film [arrangement or] structure 5 [(referring to the film 5)] is worth consideration, [for the fact that] because one may therewith enclose or cover [(coat over)] the outer surface area of the insulation packet 1 on all side areas with a single film 5 [(encasing or covering film)] consisting of the same common film material, from the point of view of a rational fabrication of the insulation arrangement. This film 5 will function in such a manner, whereby the diffusion resistance coefficient is large in a direction toward the internally located insulation packet 1 which is entirely covered or encased by the film 5. In other words, no water [(]vapor[)] can penetrate inwardly entirely to the insulation packet 1. The film 5 acts as a moisture blocker, [(as] i.e. a vapor barrier[)]. In the opposite direction, the film 5, however, has a different diffusion resistance coefficient, which is as small [(low)] as possible, so that in the given case, the [accumulated] water accumulated inside the inwardly located [from] [the] insulation packet 1 [(from the inwardly located insulation)] can easily diffuse out of the insulation packet 1 in the form of water vapor.

Returning to [the] Fig. 2, as mentioned, a film casing or covering is utilized, which is assembled or made up of two film sections or films 2, 3 of different types of materials. The two films 2, 3 are fixedly [(]and seamlessly[)] joined with each other along their film edges, so that one obtains a film casing or cover according to the example of the Fig. 3. Furthermore, it is a prerequisite, as already explained with regard to Fig. 1, that the insulation arrangement [(]according to the Fig. 2[)], with the film casing or cover made up of [a] first and [a] second films 2, 3, is likewise

arranged within the mentioned interspace which is enclosed by the inner trim component 12 (cabin trim paneling) and the (metal) outer skin 6 of the aircraft.

Thereby the insulation packet 1, which is fully covered or encased by the film 5 (made up of the two films 2, 3), will not completely line the interspace. Thereby the insulation arrangement will always be surrounded by a (certain) hollow air space, due to an intended (and below described) supply of conditioned air 11 as will be described below

This film (casing) 5 that is fused at the film edges (of two films 2, 3) completely encloses the insulation packet 1 and lies thereon in such a manner so that the film surface of a first film 2 predominantly is arranged lying on the stringer 8. The film surface of a second film 3 predominantly is positioned opposite the surface of the inner trim component 12 facing toward the inner space 7. The above descriptions say that the films are "Predominantly" p arranged as stated because certain edge regions or portions of the surface, that are limited to the section(s) of the fusion of both films 2, 3, are oriented in the direction of the lengthwise extension (the extended length) of the inner trim component 12 or of the stringer 8, and from there the above mentioned conditioned air 11 will also enter into the mentioned inner space 7.

Thereby the first film 2 will lie on the extended surface area of the stringer 8, thus in the selected example, not lying on the inner trim component 12. Since the second film 3 is located free in the inner region 7 (and not lying on the inner trim component

12~~)~~, the second film 3 will be surrounded most extensively by the conditioned air 11 flowing through the inner region 7.

It is also mentioned at this point, that several spacer members are arranged between the outer skin 6 and the insulation packet 1, or between the stringer edge ~~(of the stringer 8)~~ and the insulation packet 1. Hereby an air gap s is formed.

The first film 2 consists of ~~is realized with~~ a film material that provides ~~achieves~~ a low diffusion resistance coefficient in the diffusion direction of the gas diffusing through the film wall from the film inner wall surface to the film outer wall surface. The term gas is understood to mean, as mentioned previously, relatively warm air, which is loaded with high moisture or humidity, which flows through the slits and openings of the inner trim component 12 into the inner region 7.

The second film 3 consists of ~~is realized with~~ a film material that provides ~~achieves~~ a high diffusion resistance coefficient in the diffusion direction of the gas diffusing through the film wall from the film outer wall surface to the film inner wall surface.

According to all embodiments of the described insulation arrangement, the film-encased insulation packet 1 comprises ~~is realized with~~ an insulation material consisting of polyphenylene sulfide (PPS) ~~(short designation: "PPS")~~. The latter is covered or encased by the ~~individual~~ single film 5 embodied as a synthetic plastic film ~~(according to the Fig. 3)~~ or by the film arrangement ~~which consists~~ consisting of two different types of films 2, 3 ~~(according to the Fig. 2)~~ which are

combined together to form thereof combined according to Fig. 2 a single film 5. Thereby the film material(s) of the film 5 [~~(which may be combined together of two different types of film materials in a given case) (according to the film structure according to the Figures 2 and 3) realizes (realize)~~] provide(s) a differential diffusion resistance coefficient, depending on the direction of the (occurring) diffusion through the film wall, as described previously. Their spatial arrangement within the inner region or interspace 7 [(or the interspace)] is adapted, at the location of their contact surface, to the surface contour of the surface of the stringer 8 (oriented toward the inner trim component 12) [or (but also)] and to the surface contour of the inner surface of the outer skin 6 respectively.

Summarizing the above discussion, [In closing it is summarized that] ~~the~~ different films 2, 3, 5 [(film coverings or casings)] according to [the] Figures 2 and 3 consist of different types of film materials, so as to prevent [that] an accumulation of condensate water in the insulation packet 1 encased by the film [is excluded]. The [A] second film 3 [(according to [the] Fig. 2)] facing toward the inner region A [will] comprises a film material that provides a high diffusion resistance coefficient in the vapor diffusion direction [of the medium] [from the film outer (wall surface) ~~to the~~ film inner [(wall)] surface]. That has the advantage that the air that is loaded with a [(relatively)] high moisture or humidity, which flows in through slits and openings from the inner region A (for example from the passenger cabin of an aircraft) into the interspace 7 [intermediate region (into the inner region 7)], cannot diffuse directly into the primary insulation [(arranged close to the aircraft fuselage structure)]. At the area of the insulation arrang ment oriented toward the outer skin 6 [(as a component of

the aircraft fuselage structure), a the first film 2 (according to the Fig. 2) is utilized, which is open to diffusion and which comprises a low diffusion resistance coefficient in the vapor diffusion direction of the medium from the film inner wall surface to the film outer (wall) surface.

The above construction provides

This has the advantage, (primarily during warm ground times (ground phase of an aircraft) that liquid water, which has accumulated by condensation in the insulation packet 1, can escape from the insulation packet 1 as water vapor in a (relatively) unhindered manner ~~and therewith quickly~~, primarily while the aircraft is on the ground at a warm temperature. Thereby a drying of the insulation packet 1 is dried strived for. For this purpose Thereby it is a prerequisite that a sufficient air gap s exists between the outer skin 6 and the first film 2. The stringer 8, on which lies the primary insulation, thereby functions as a spacer member relative to the outer skin 6. Additional holder elements will serve to maintain, or to enlarge if necessary, the air gap region 10 between the outer skin 6 and the insulation arrangement, i.e. (the film-encased insulation packet 1). Thus, two essential effects in comparison to the conventionally utilized aircraft insulation are achieved two essential effects by the invention:

a) the The water vapor, which can come from the inner ~~region A~~ (originating from the passenger cabin) into the interspace or (inner region 7), is prevented from penetrating i.e. (from diffusing) into the insulation packet 1 by the second film 3 functioning as a vapor barrier;.

b) the The liquid water, which nonetheless collects in the insulation packet 1, may, for example, leave the insulation packet 1 in the form of water vapor through the diffusionally open first film 2, during the warm ground phase of an

aircraft. Thereby a drying of the primary insulation is supported, and therewith the accumulation of condensate water in the insulation system is prevented.

Both embodiments of the presented insulation arrangement according to the Figures Figs. 2 and 3 possess provide the advantage of achieving that one achieves an additional drying effect even during cruise flight (in the cruise flight of an the aircraft) with conditioned air, which is one additionally supplies supplied to the affected insulation arrangement by means of an active air conditioning device (air conditioning apparatus). This is especially because the film construction according to the Fig. 3 will ensure that the insulation packet 1 can be dried out by the above discussed selective outward diffusion even dry out at all. Overall, the following advantages are achieved with the presented insulation constructions:

a) Less water vapor will enter into the insulation packet 1, so that also less condensation takes place in the insulation packet 1; .

b) Condensate water, which has once collected in the insulation packet 1, can again escape from the insulation in the form of water vapor; .

c) The insulation packet 1 can more easily be dried after all of the above; .

d) There no longer arises an accumulation of condensate water will no longer accumulate in the insulation packet 1, .

e) Because less water is present in the insulation, the operating life of the insulation arrangement or the insulation system is increased; .

f) Corresponding weight is saved in the air vehicle e.g. (for example in the aircraft), whereby the flight capacity is increased;.

g) The suggested measures may be carried out realized without special effort. That applies also to retrofitting of air vehicles (aircraft) located that are already in service;.

h) If, nonetheless, the utilization of a drying system is provided and used in the air vehicle (in the aircraft), for drying the structure, then the described insulation arrangement according to the Figures 2 and 3 may be installed to be just as effective as necessary. achieve an enhanced drying effectiveness.

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ABSTRACT OF THE DISCLOSURE

Insulating Arrangement for the Inner Insulation of an Aircraft

~~The invention relates to an insulation arrangement for the inner insulation of an air vehicle according to the preamble of the claim 1.~~

~~By means of appropriate measures (and air guidances) there will be almost no humid air or other humid gas or water (vapor) particles that will penetrate into a film encased insulation packet, whereby oppositely (in the case of an accumulation in this manner) the accumulated moisture will quickly and without hindrance escape from the insulation packet.~~

~~The~~ An insulation arrangement that is made up of insulation material includes ~~consisting of~~ an insulation packet~~,~~ and that ~~which is~~ is completely encased by a film. The film is arranged in an interspace~~,~~ ~~which is enclosed by~~ between an inner trim component and an outer skin of an aircraft. The insulation packet~~,~~ which is completely surrounded by the film~~,~~ does not completely ~~line~~ fill the interspace, but rather leaves an air space. The film ~~is realized with~~ consists of a film material that ~~is permeable by gases, with which one achieves~~ provides differentially gas permeable a differentiated diffusion resistance ~~behavior~~ with respect to water vapor diffusing therethrough, dependent on the ~~diffusion~~ direction of ~~the total arrangement~~ the diffusion through the film. Preferably the resistance to diffusion of water vapor into the insulation packet through the film is higher than the resistance to diffusion of water vapor out of the insulation packet through the film. The accumulation of moisture in the packet is avoided.

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